Space Weather Technical Forecast

Issued on Thursday, 14 April 2022 at 01:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrival on day 1, with G1 storms expected and a chance of G2 storms. Slight chance of G3 storms. Decreasing chance of geomagnetic storms from day 2 onward.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been very low, with no C-class flares observed. There are four sunspot regions on the visible disc, two beta regions AR2989 (Bxi/Beta) and AR2990 (Bxo/Beta) and one fading alpha region, AR2988 (Axx/alpha) in the northeast. There is also an unnumbered Axx/alpha region on the southeastern limb. There were two CME eruptions observed on STEREO A imagery in the last 24 hours, although neither appear to be Earth directed based on preliminary analysis.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1, has followed a steadily declining trend from 500km/s to 420km/s by the end of the period. Density fell from around average values to below average values, but started to increase towards average levels by the end of the period. Total magnetic field, Bt, has been mainly moderate, peaking at 11.3nT at 13/0933UTC, before weakening as the Earth moves through the magnetic cloud from the CME which arrived early on 13 April. The north-south component, Bz fell to -6nT following the onset of the magnetic cloud, and has slowly rotated back into a weakly positive orientation. The phi angle started negative, but became predominantly positive from 13/0200UTC. Geomagnetic activity started Unsettled, but has been Quiet for much of the period.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured at GOES-16 at GEO was at background levels. The high energy electron flux (greater than 2MeV) started at background, then increased to mainly moderate levels from around 13/0600UTC. The flux reached high levels between 13/1325UTC and 13/1425UTC peaking at 1.42e3 pfu at 13/1350UTC. Electron fluence has been below the Active threshold throughout and has levelled out.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be very low, with no significant regions on, or expected to rotate onto, the visible disc.

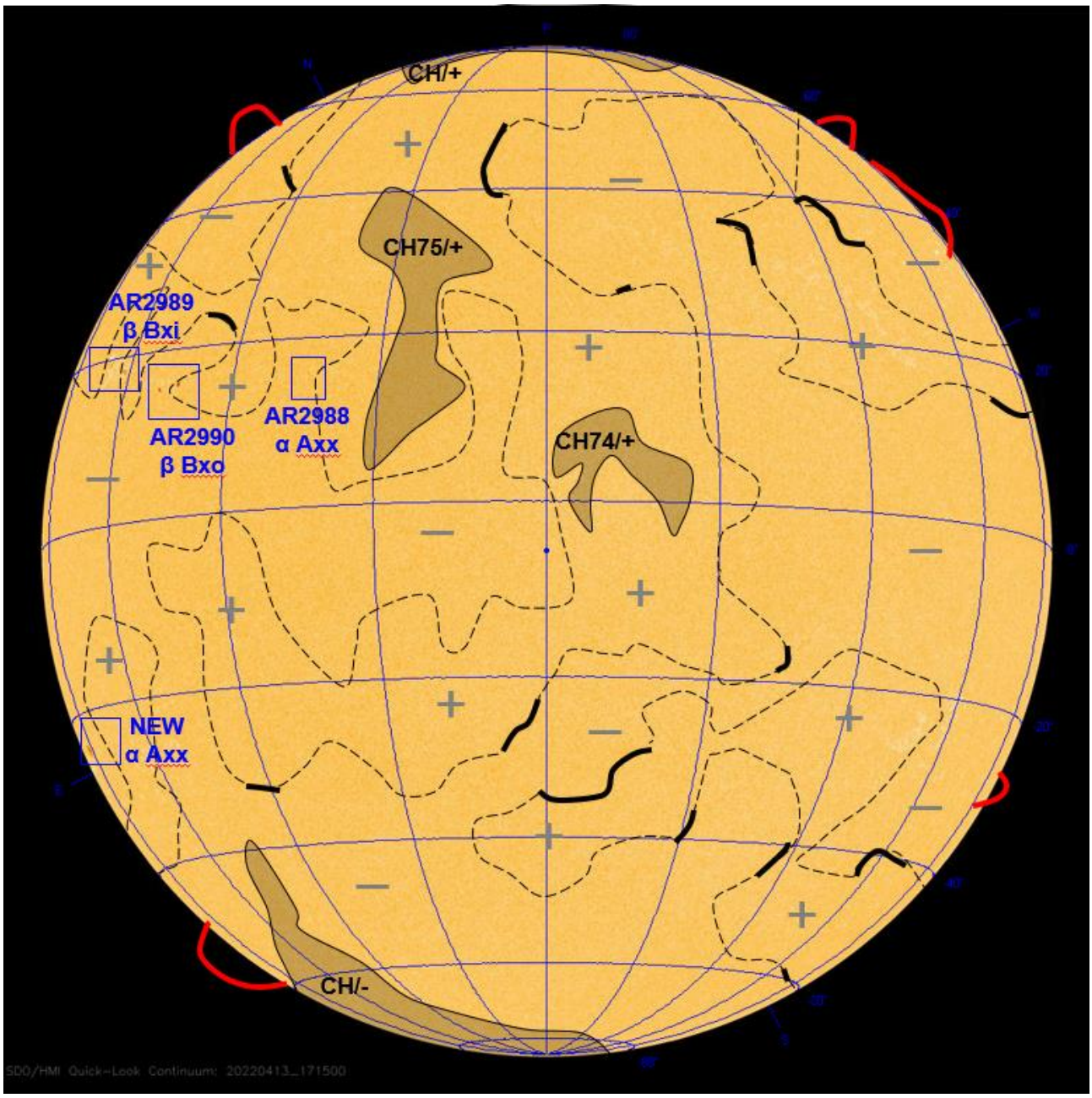
Solar Wind / Geomagnetic Activity: A CME which arrived on 13 April, continues to affect the Earth, but with a declining influence. A further Earth-directed CME is forecast to arrive at Earth later on 14 April, with a speed of 500km/s. Aside from the CME, the high speed stream from coronal hole 73 continues to decline. The next high speed stream, from coronal hole 74, is due to connect with the Earth on day 3 (16 April), with estimated speeds of 500km/s. Geomagnetic activity is expected to increase from Quiet to Unsettled, reaching Active or G1/Minor Storms on day 1, due to the CME arrival. There is also a chance of G2/Moderate Storm intervals and a very slight chance of G3/Strong Storm intervals. There is a decreasing risk of G1/Minor Storms through days 2 to 4 (15 to 17 April) due to a combination of residual CME effects and the potential high speed stream connection.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to persist at background levels. High energy electron flux (greater than 2MeV) is expected to be mainly below the high threshold through days 1 to 3 (14 to 16 April) due to geomagnetic activity, with a slightly increased chance on day 4. Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 1. Solar Analysis Valid 13/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

The effects of a CME which left the Sun on 9 April, and which arrived at Earth on 13 April are expected to continue to decline through the next 24 hours. A further Earth-directed CME is expected to arrive at Earth later on 14 April.

In addition to the CME arrivals, the high speed stream from coronal hole 73 is waning as the feature rotates out of view of the Earth. The next high speed stream, from coronal hole 74 is due to connect with the Earth on day 3 (16 April), with an estimated speed of 500km/s. Both the timing and speed of any connection is low confidence as there is no evidence of the high speed stream on STEREO A data.

Geomagnetic activity is expected to start Quiet to Unsettled, but rapidly increase to Active or G1/Minor Storm intervals due to the onset of the 11 April CME. There is also a chance of G2/Moderate Storms and a slight chance of G3/Strong Storm intervals depending on the speed of the impact and the polarity of the originating filament. There is also a very slight chance of G4/storm intervals. Residual effects are then likely into day 2 (15 April), with further G1/Minor Storm intervals possible. The connection of the high speed stream on day 3 (16 April) could result in G1/Minor Storms, but the low probability reflects the low confidence in the strength and timing of the connection.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	40	20	10
Strong	G3	No	10	1	1	1
Severe	G4	No	2	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0521UTC	Full	Filament eruption	South centre disc	500km/s	14/1800UTC +/-6 hours	G1/G2 forecast

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 2: DSCOVR observation of the total magnetic field and north-south Bz component, showing the magnetic 'cloud' affecting the Earth.

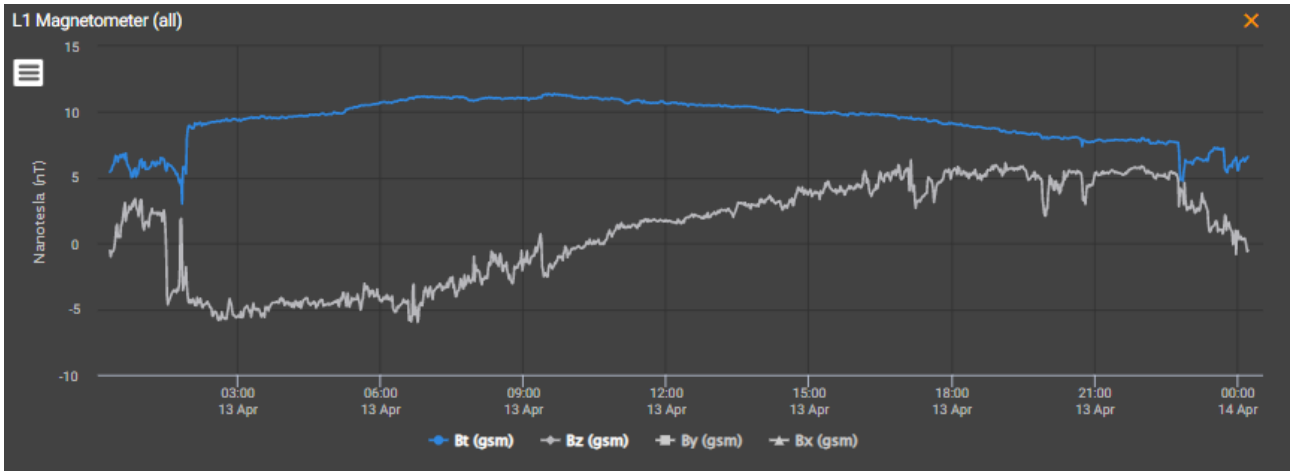
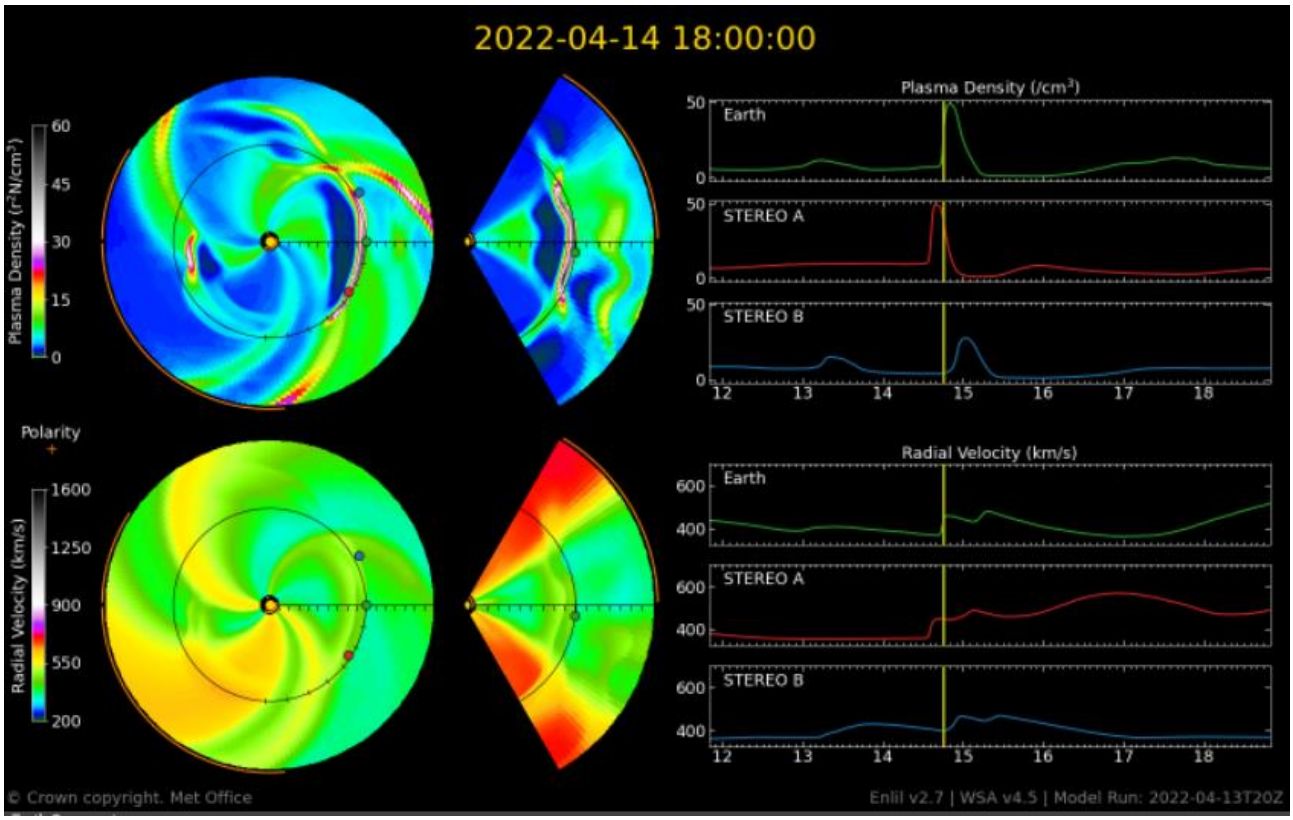


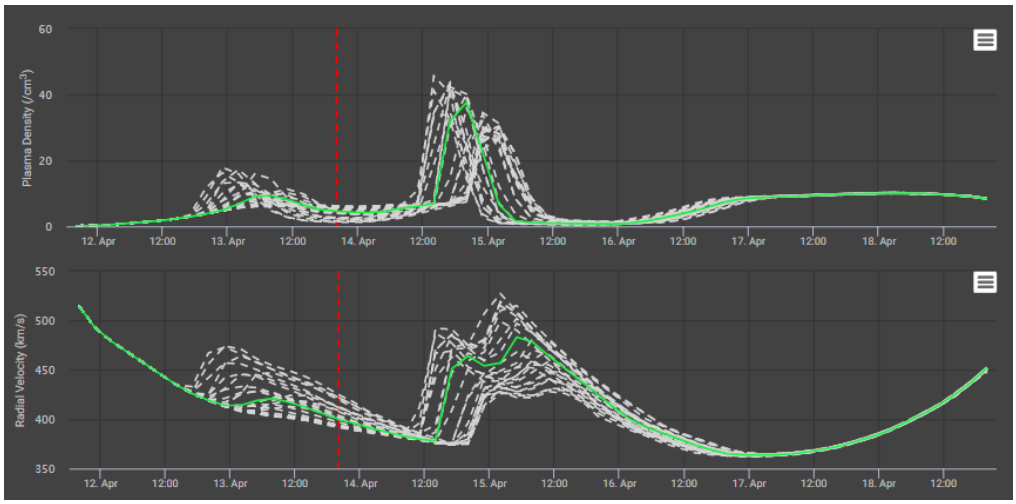
Figure 3: MOSWOC Enlil showing the most likely arrival time of the CME which is expected on 14 April.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Figure 4: MOSWOC Enlil Ensemble, showing potential range in arrival times for the CME.



Radio Blackouts - X-Ray Flares:

There are three benign numbered sunspots on the visible disc, with none of these presenting a significant flare risk. A new unnumbered region on the southeast limb has not yet been fully analysed, but also appears to be relatively simple. A number of returning sunspot regions are due to rotate across the eastern limb by the end of the period, with the prominences from these visible on STEREO EUVI imagery. These regions will be monitored for any significant activity as they move close to the eastern limb.

Solar activity is expected to be mainly very low.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	1	1	1	1
Very Active	R3 to R5 X Class	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as measured by GOES-16 at GEO is at background and in the absence of complex sunspots on the Earth-facing disc is expected to remain at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) may exceed the high (1e3pfu) threshold ahead of the CME arrival on day 1. Increased geomagnetic activity, combined with the speed of the expected CME later on day 1, are likely to lead to distortion of the radiation belts out of their normal orbits and displacement of the electrons within the belt, both reducing electron counts. Geomagnetic activity is expected to decrease through the period, with the radiation belts slowly relaxing into their original orbits and leading to a subsequent sharp increase in electron flux by the end of the period. The magnitude of this increase is dependent in the amount of electrons input into the near-Earth environment by the CME and the high speed stream on days 3 and 4 (16 and 17 April).

Electron fluence is expected to follow a flat trend over the next 24 hours, but with a sharp decrease in response to the increased geomagnetic activity. A sharp increase is then likely on day 4 (17 April) due to the increased flux, but there is uncertainty in whether the Active (1e8 integrated pfu) threshold is reached.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.